Progress Report RSC 3273-5 & 6

E7.7-10166

CR-152667

SPECTRAL MEASUREMENTS OF WATERSHED COEFFICIENTS IN THE SOUTHERN GREAT PLAINS

Principal Investigator
Bruce J. Blanchard
Remote Sensing Center
Texas A&M University
College Station, Texas 77843

March 1977
Type II Report for Period
September 1, 1976-February 28, 1977

Prepared for

Goddard Space Flight Center
Greenbelt, Maryland 20771

Contract No. NAS5-22534

TEXAS A&M UNIVERSITY
REMOTE SENSING CENTER
COLLEGE STATION, TEXAS

Progress Report RSC 3273-5&6

SPECTRAL MEASUREMENT OF WATERSHED COEFFICIENTS IN THE SOUTHERN GREAT PLAINS

Principal Investigator
Bruce J. Blanchard
Remote Sensing Center
Texas A&M University
College Station, Texas 77843

March 1977
Type II Report for Period
September 1, 1976-February 28, 1977

Prepared for
Goddard Space Flight Center
Greenbelt, Maryland 20771

Contract No. NAS5-22534

Table of Contents

SPECTRAL MEASUREMENTS OF WATERSHED COEFFICIENTS IN THE SOUTHERN GREAT PLAINS

1.0 BACKGROUND AND SUMMARY

1.1 Background

This investigation is directed toward testing and modifying a technique developed in a previous study (Contract #5-70251-AG TASK #5) where a linear combination of Landsat data was related to watershed runoff coefficients. The relationship was developed and tested in a region of central Oklahoma where extensive rainfall and runoff data were available for research watersheds.

In this study the technique will be tested in two regions; one in central and east central Texas having more dense vegetation than Oklahoma and the other in arid regions of Arizona and New Mexico where vegetation is less dense. In each region, twenty watersheds will be selected on a basis of the most adequate records of rainfall and runoff. The technique will be tested in each region by developing a relationship between spectral response and runoff coefficients based on ten watersheds and then testing the prediction capability of the relationship on the remaining watersheds in that region.

It is expected that by testing the technique in regions having more dense and more sparse vegetation

on the watershed surfaces, an estimate can be made of the area where the technique is applicable. At the same time, the influence of the quality of rainfall and runoff data used to calibrate the prediction scheme should indicate whether the technique can be useful to practicing hydrologists.

1.2 Summary

Runoff coefficients were determined for the U. S. Geological Survey (U.S.G.S.) gauged watersheds. Boundaries for these watersheds were outlined on topographic maps. Boundary points in latitude and longitude were taken from the topographic maps and tabulated for all the watersheds studied in Arizona and New Mexico.

Antecedent precipitation index (API) values were calculated for several dates of coverage by Landsat II for the Arizona and New Mexico watersheds. Scenes during the dormant season and with the lowest API value were selected.

Average spectral reflectance values for multispectral scanner bands four, five, six and seven were determined for the study watersheds. Procedures used to arrive at these values were somewhat different than the procedures used to obtain the spectral reflectance values of the Texas watersheds.

2.0 ACCOMPLISHMENTS AND PROBLEM AREAS

2.1 Accomplishments During the Reporting Period

Rainfall-runoff data were tabulated for 15 to 20 runoff producing storms from the period of record for the selected U. S. Geologic Survey (U.S.G.S.) gauged watersheds in Arizona. Rainfall reporting stations in Arizona are sparse, thus any available records in the vicinity of the watershed location were utilized. Occasionally a reporting station was within a watershed boundary, but most of them were fairly distant from the watershed. Since most of the rainfall reporting stations were distant from the watersheds, storms were selected that had approximately equal rainfall amounts reported. Therefore, the amount of rainfall associated with a given runoff volume was an arithmetic mean if two or more rain gauges were utilized. Rainfall records were obtained from climatological data summaries from Arizona. Runoff volume for the watersheds were obtained from the surface water records for Arizona published annually by the U.S.G.S. Watershed runoff ceofficients were determined as previously reported (Progress Report RSC 3273-4) for these watersheds. The watersheds are listed in Table 2.1.1 as well as their aerial extent, Hawkins k, and Hawkins CN for a five inch rain.

Table 2.1.1

Hawkins CN for U.S.G.S. Gauged Watersheds in Arizona

Watershed	Area (mi^2)	Hawkins k	Hawkins CN for 5" rain
E. Fk. White R.	38.8	0.48	47.15
Pahceta Cr.	14.8	0.26	47.15
Nutrioso Cr.	83.4	0.18	41.54
Sabino Cr.	35.5	0.74	81.18
Bear Cr.	16.3	0.69	77.60
Rincon Cr.	44.8	0.52	66.06
Tanque Verde Cr.	43.0	0.68	76.90
New River	83.3	0.48	62.53
Wet Bottom Cr.	36.4	0.51	64.93
W. Fk. Sycamore Cr.	9.8	0.49	63.43
Sycamore Cr.	52.3	0.36	54.36
Rattlesnake Canhon	24.6	0.60	71.76
Red Tank Draw	49.4	0.51	64.94
Wet Beaver Cr.	111.0	0.50	64.43

The watershed boundaries were outlined on topographic maps to delineate the watersheds. Watershed boundary points in latitude and longitude were taken from the topographic maps for the U.S.G.S. watersheds as well as for the 27 experimental watersheds reported previously (Progress Report RSC 3273-4) and tabulated for future reference.

Landsat-2 scenes were selected to cover the watersheds of interest on the basis of low antecedent precipitation index (API) during the dormant season of the year. API values were determined by a 30 day decay method for several selected dates of coverage during the dormant season. Rainfall data were recorded for all reporting stations that surrounded the watersheds covered by the scene for 30 days prior to the date of coverage. From this, an average API value was computed and assessed to each scene. Landsat scenes selected had API values between 0.00 and 0.15 inch. Computer compatible tapes (CCTs) corresponding to these scenes were ordered.

Procedures used to obtain the spectral reflectance of a given watershed from multispectral scanner (MSS) bands four, five, six and seven were somewhat different from those used in the Texas watershed study. A block of data containing the watershed was moved from the CCTs and stored in a disk file for future use. Input to the computer program that transferred this block of data was

beginning and ending record and beginning and ending pixel. A grey map of the area was then obtained as before. To locate the watershed on the grey map, at least five identifiable points were selected (usually more) to correlate latitude and longitude to the corresponding record and pixel with a multiple linear regression computer program. If the correlation coefficient was of sufficient magnitude (on the order of 0.99), the watershed boundary points in latitude and longitude were converted into records and pixels. The equations used to convert latitude and longitude to records and pixels were of the form:

$$\text{Record} = A_1 \times \text{Latitude} + \text{Longitude} + A_0$$

$$\text{Pixel} = B_1 \times \text{Latitude} + B_2 \times \text{Longitude} + B_0$$

where A_1, A_2, A_0, B_1, B_2 and B_0 are coefficients determined by multiple linear regression. The watershed was then outlined on the grey map and the average spectral reflectance for the four MSS bands were obtained for the data within the watershed boundary. This procedure was the same as that used for the Texas watersheds. Values obtained for each of the watersheds are presented in Table 2.1.2.

2.2 Problem Areas

None.

TABLE 2.1.2

Area, Curve Number and Spectral Reflectance for Watersheds in Arizona and New Mexico

Watershed	Area	Hawkins k	Hawkins CN for 5" rain	band 4	band 5	band 6	band 7	$\overline{\mu}_5 - \overline{\mu}_4$	$\overline{\mu}_5 + \overline{\mu}_6 - (\overline{\mu}_5 - 2\overline{\mu}_7)$
Albuquerque W-1	97.2	0.52	65.90	29.32	42.79	47.90	20.06	13.47	21.25
Albuquerque W-2	40.5	0.57	69.38	31.31	48.19	54.00	22.04	16.88	26.80
Albuquerque W-3	168.0	0.46	61.75	28.98	44.27	49.66	20.74	15.29	23.47
Safford W-1	519.0	0.47	62.18	24.68	37.62	42.72	16.52	12.94	22.62
Safford W-2	682.0	0.48	63.19	29.54	47.53	53.79	22.01	17.99	27.76
Safford W-4	764.0	0.37	54.98	32.87	55.26	62.73	25.24	22.39	34.64
Safford W-5	723.0	0.32	51.59	25.37	37.67	47.40	19.83	12.30	20.04
Walnut Gulch W-3	2,220.0	0.39	56.60	22.10	33.74	38.39	16.18	11.64	17.67
Walnut Bulch W-4	560.0	0.55	67.85	20.71	30.76	34.87	14.56	10.05	15.80
Walnut Bulch W-11	2,035.0	0.52	65.80	21.64	32.49	37.44	15.86	10.85	16.57
Atterbury W-2	2,944.0	0.25	46.53	26.89	41.26	46.98	19.86	14.37	21.63
Atterbury W-3	300.8	0.30	49.66	27.45	42.57	48.57	20.54	15.12	22.61
Tanque Verde Cr.	27,520.0	0.68	76.90	17.87	24.88	31.65	14.14	7.01	10.38
Rincon Cr.	28,672.0	0.52	66.06	16.69	22.92	30.91	14.17	6.23	8.80
Sabino Canyon	22,720.0	0.74	81.18	14.86	19.52	30.67	15.19	4.66	4.95
Bear Cr.	10,432.0	0.69	77.60	15.52	20.71	31.32	15.28	5.19	5.95
E. Fk. White River	24,832.0	0.48	62.99	9.49	10.57	25.40	13.34	1.08	-0.20
Pacheta Cr.	9,472.0	0.26	47.15	10.45	12.94	27.54	14.32	2.49	1.39
Nuturiso Cr.	53,376.0	0.18	41.54	11.86	15.19	27.73	13.72	3.33	3.62
E. Fk. Seven Springs	748.0	0.14	38.79	15.43	22.61	34.69	16.88	7.18	8.11

Table 2.1.2 (cont.)

Watersheds	Area	Hawkins k	Hawkins CN for 5" rain	band 4	band 5	band 6	band 7	$\bar{\mu}_5 - \bar{\mu}_6$	$\bar{\mu}_5 + \bar{\mu}_6 - (\bar{\mu}_5 - \bar{\mu}_7)$
E. Fk. Castle Cr.	1,163.2	0.38	55.57	9.66	10.97	22.83	11.46	1.31	1.22
N. Fk. Thomas Cr.	467.0	0.19	41.84	9.22	10.14	25.11	13.15	0.92	-0.27
S. Fk. Thomas Cr.	562.0	0.18	41.59	8.59	9.13	22.30	11.59	0.54	-0.34
Willow Cr.	298.0	0.22	44.64	9.06	10.17	24.44	12.95	1.11	-0.35
E. Fk. Sycamore Cr.	2,873.6	0.28	48.62	14.34	17.01	33.47	16.74	2.67	2.66
W. Fk. Sycamore Cr.	2,931.2	0.27	47.78	13.78	16.64	32.62	16.37	2.86	2.73
W. Fk. Sycamore Cr.	6,272.0	0.49	63.43	14.02	16.89	32.78	16.32	2.87	3.01
Sycamore Cr.	33,472.0	0.36	54.36	16.62	21.28	33.35	15.38	4.66	7.25
New River	53,312.0	0.48	62.53	21.36	29.88	36.68	15.31	8.52	14.58
Wet Bottom Cr.	23,296.0	0.51	64.93	15.11	19.89	31.03	14.26	4.78	7.29
Wet Beaver Cr.	71,040.0	0.50	64.62	14.54	19.69	30.21	14.02	5.15	7.32
Red Tank Draw	31,616.0	0.51	64.94	15.90	21.96	31.05	13.97	6.06	9.17
Rattlesnake Canyon	15,744.0	0.60	71.76	13.96	18.49	29.18	13.50	4.53	6.71
Beaver Cr. W-4	346.0	0.52	65.69	16.89	25.24	33.11	14.69	8.35	12.08
Beaver Cr. W-8	1,802.0	0.48	62.90	11.63	14.30	28.19	14.01	2.67	2.84
Beaver Cr. W-13	910.0	0.43	59.23	12.49	15.28	29.41	14.37	2.79	3.46
Beaver Cr. W-18	242.0	0.65	74.75	13.33	17.63	29.92	14.15	4.30	5.92

2.3 Recommendations

None.

2.4 Accomplishments Expected During the Next Quarter

Timber cover will be estimated on the Arizona watersheds from orthophotoquads. All data will be reduced to final form. Spectral reflectance and curve number will be correlated for the Texas and Arizona watersheds.

3.0 SIGNIFICANT RESULTS AND PRESENTATIONS

3.1 Significant Results

None.

3.2 Presentations

None.